1902MNRAS..62..516S

An instance is quoted in which such a discrepancy persists even for different images of the same star (§ 14).

University Observatory, Oxford:
1902 *May* 7.

Visual and Spectroscopic Observations of the Sun-spot group of 1901 *May* 19–*June* 26. By the Rev. A. L. Cortie, S.J., F.R.A.S.

The group of Sun-spots of 1901 May 19–June 26, seen during two solar rotations, is noteworthy for several reasons. First, it was a large group visible to the unaided eye, occurring at a time of Sun-spot minimum. If one group of small spots seen between March 3–11 be excepted, the solar surface had been quiescent for almost exactly six months before the appearance of this group, without any spots and with very few faculæ, and these faculæ more than ordinarily faint. The following table deduced from the Stonyhurst series of Sun-spot drawings, supplemented by a very full series of direct visual observations by Mr. Hadden, of Alta, Iowa, U.S.A., shows the quiet state of the solar surface between 1900 November and 1901 April before the advent of the big group of May–June. The greatest visible disc-area of the group from the Stonyhurst drawings was 7·6 on May 22, the unit being $\frac{1}{5000}$ of the visible disc. In the former Sun-spot minimum of 1889 a big spot also appeared, that of June, as a contrast to the general quiescence. The recurrence of the phenomenon during the present minimum, even if only a coincidence, is noteworthy.

Month.	Days of Observation.	Mean Daily Number of Groups.	
		Spots.	Faculæ.
1900 November	26	0·42	0·62
December	29	0·10	0·59
1901 January	28	0·00	0·18
February	26	0·31	0·58
March	30	0·53	0·63
April	30	0·00	0·70
May	31	0·61	1·09
June	30	0·73	0·73

1. A unique interest attaches to the 1901 outburst in that, as Mr. Perrine and the Greenwich observers have shown, it was very close in position when just out of sight beyond the E. limb on May 18, to a fine prominence, and, what is still more remarkable, to a disturbed area of the solar corona observed during the total

1902MNRAS..62..516S

solar eclipse of that date. In a previous short account of this Sun-spot group communicated to the *Observatory* (No. 306, June 1901), and before any knowledge of the coincidence in position of the Sun-spot, prominence, and coronal disturbance was attainable, it was stated that "the group was born very close to the E. limb on the invisible side of the Sun, being probably two or three days old when first observed at Stonyhurst on May 20th." In the paper, "On the Types of Sun-spot Disturbances" (*Astrophysical Journal*, vol. xiii. No. 4, May 1901), it is shown how it is possible from the type of a Sun-spot to give a very fair estimate of its age and the date of its birth, even if, as in the present case, it was born on the invisible side of the Sun. It is then most likely—in fact almost certain—that the disturbance in the corona was not only coincident in position with the Sun-spot, but in time also with the date of its birth, and that we witnessed in the corona the effects of the solar disturbance accompanying the birth of the spot.

2. Premonitory signs of this, the only great outburst of the year, had been given for about a month previously to its appearance. On the drawings of April 15, 16, 17, the observer notes that regions north of the equator were disturbed as indicated by the appearance of many groups of evanescent veiled spots. On the 20th the Sun's surface displayed most active and continual changes in the appearance and disappearance of veiled spots. It is to be noted, too, from the table given above that the mean daily number of faculæ gradually increases from January to April, even though they were faint and not very extensive. On April 21 a bright patch of faculæ was both noted by Mr. Hadden and drawn by the Stonyhurst observer on the Sun's E. limb. Its character of brilliancy and compactness was such as accompanies the first appearance of Sun-spots, though on the three following days it was followed by other less brilliant faculæ of more extended area. There is a bare possibility of these faculæ indicating the region of a short-lived spot group that ran its course on the invisible side of the Sun. But the position of the bright patch of April 21 was longitude 168° and N. latitude 8°·5. This is the very position of the spot which subsequently appeared on May 19 at the next rotation, a difference of 8° in longitude between the centre of the faculous and spot groups being accounted for by the extent of the faculæ, and by the difficulty of making extremely accurate measurements when objects are close to the Sun's limb. The coordinates of the spot group on May 20 were longitude 160° and N. latitude 9°. We have here another instance of a facula preceding a Sun-spot to be added to the seven clear cases found on the Stonyhurst drawings, but in this case what is remarkable is that it precedes it by a whole solar rotation. If the barely possible surmise of the faculæ of April 21 and following days, being the remnants of a short-lived storm which had occurred on the invisible hemisphere of the Sun, be admitted, then at least we have a good instance of one spot following another in almost

1902MNRAS..62..516S

the same position, and thus giving rise to a disturbed area, observed also in the solar corona of May 18.

3. During the first appearance the spot was visible from May 19 to May 31, attaining its greatest area on May 22. From May 13 to May 22 the magnets were absolutely quiet ; from May 22 to May 29 there was a series of small disturbances. May 30 was a quiet day, followed by a small disturbance on May 31, so that during its first passage across the visible disc, when the spot displayed great activity and attained its maximum area, the magnets did not show even a moderate disturbance. In June the spot was visible for a second time from the 14th to the 26th, when it was much reduced in size, being almost extinct when it reached the W. limb on June 26. There were two moderate disturbances of the magnets on the 13th and 21st, the only two during the month. The other days were days of calm or but slight disturbance. As a set off there were also two moderate disturbances in July when the Sun's surface was almost absolutely quiescent. The one great solar disturbance of the year, therefore, which showed itself in a spot visible to the naked eye, in a fine prominence, in bright faculæ, and in a unique coronal disturbance, was unaccompanied by any considerable magnetic storm, and seemingly had but a fortuitous connection with the slight and moderate disturbances which occurred during its existence.

4. The spectrum of the spot was first observed on May 22 between 2 and 3·30 P.M., G.M.T., when the seeing was excellent. The Browning automatic spectroscope attached to the Perry Memorial 15-inch telescope was used for the observation, the full battery of 12 prisms of 60° being employed. Before the detailed examination of the portions of the spectrum contained in the following table was made, the whole of the lines between C and D were carefully passed in review several times. The lines usually observed as most widened were unchanged, the most widened lines being faint lines chiefly due to vanadium. The general absorption was only moderately dark.

Wave-length.	Element.	Widening.	Intensity.	Remarks.
6039·9	V	1·0	0	Most widened line.
6053·9	Ni	1·0	0	,, ,, ,,
6063·1	...	1·0	0	,, ,, ,, Observed May 2
6243·1	V	1·0	000	,, ,, ,,
6252·8	...	0·5	7	V line at 6252·0.
6254·4	Fe	0·5	1	
6254·5			5	
6256·6	Ni–Fe	0·5	6	
6258·3	Ti	0·8	2	
6258·6	V		000	

1902MNRAS..62..516S

Wave-length.	Element.	Widening.	Intensity.	Remarks.
6261·3	Ti	1·0	1	A V line very near.
6265·3	Fe	0·4	5	
6267·0	...	1·0	0000	A V line at 6269·0.
6274·8	...	1·0	00	A line just before head of *a* band, always very widened.
6282·9	Co	0·5	2	
6291·2	Fe	0·5	4	
6293·0	V	0·5	000	
6296·2	A(O)	0·5	3	Widening perhaps due to a V line at 6296·6.
6306·0	O	1·0	2	Some other lines in the *a* band were somewhat widened or darkened, but this pair was quite conspicuous, especially the more refrangible line.
6307·0	O	1·0	2	
6311·7	Fe	0·5	1	
6322·9	Fe	0·5	4	
6330·3	Cr	0·5	1	A Fe line very close.
6344·4	Fe	0·5	4	
6355·2	Fe	0·5	4	
6358·9	Fe	0·5	6	
6393·8	Fe	0·5	7	A close double.
6400·2	Fe	0·5	8	” ” ”
6405·9	...	0·8	00	
6408·2	Fe	0·5	5	
6411·8	Fe	0·5	7	
6415·2	...	...	1	Obliterated over spot.
6417·1	Fe ?	...	1	” ” ”
6420·2	Fe	0·5	4	
6421·6	Fe	0·5	7	
6431·1	Fe	0·3	5	
6432·9	Fe?	0·8	1	
6436·6	Fe?	0·8	0	
6439·3	Ca	0·5	8	
6450·0	Ca	0 5	6	
6455·8	Ca	0·8	2	
6456·6	...	0	3	
6462·8	Ca	0·5	5	
6463·0	Fe		3	
6469·4	...	0·5	2	Also darkened in spot.
6471·9	Ca	0·5	5	” ” ”
6475·8	...	0·8	2	” ” ”
6494·0	Ca	0·5	6	

1902MNRAS..62..516S

Wave-length.	Element.	Widening.	Intensity.	Remarks.
6495·2	Fe	0·5	8	
6499·9	Ca	0·8	4	
6546·5	Ti–Fe	0·4	6	
6563·0	Hα	0	40	

The identification of the lines during the observations was made by means of Higgs's Photographic Atlas of the Normal Solar Spectrum. The wave-lengths, elements, and intensities are taken from Rowland's Preliminary Table of Solar Spectrum Wave-lengths. The widening of the lines is estimated as far as possible in terms of the normal width of the line. The observations of May 22 were revised on May 23 and 24, employing the 1st and 2nd orders of a Rutherfurd grating. The same lines were affected. The most widened line between D and *b* seemed to be 5210·6, due to titanium.

The following table gives a comparison between the average widening and average intensity of the lines of the various elements observed. In Rowland's table the intensities of the lines are reckoned from 1, a line just clearly visible on the map, to 1000 for H and K. Faint lines below intensity 1 are reckoned in order of faintness from 0 to 0000. In taking an average of the intensities of the lines of any one element observed, 0 to 0000 for the sake of comparison have been reckoned as —1 to —4.

Element.	Number of Lines Observed.	Mean Widening.	Mean Intensity.
Iron	19	0·5	+ 5·2
Calcium	7	0·6	+ 5·7
Titanium	3	0·7	+ 3·0
Vanadium	4	0·8	− 2·5
Nickel	2	0·8	+ 2·5
Cobalt	1	0·5	+ 2·0
Chromium	1	0·5	+ 1·0
Oxygen?	2	1·0	+ 2·0
Hydrogen	1	0·0	+ 40·0
Unknown	8	0·7	+ 0·6

Excluding the lines of unknown origin, the two doubtful lines of oxygen, and the single lines of cobalt and chromium, the mean widening is almost inversely as the mean intensity. This fact again corroborates the statement made in several previous papers (*e.g. Monthly Notices, R.A.S.* vol. xlix. No. 8, June 1889, p. 417), that at least in this portion of the spectrum the most widened lines in Sun-spots are at all periods of solar activity faint lines due principally to vanadium. In the case of iron and titanium we find in the spot-spectra the same relation between

1902MNRAS..62..516S

widening and average intensity as is found by Mr. Evershed (*Memoirs R.A.S.* Appendix II. vol. liv. 1901, p. [91]) between intensity in the "flash" spectrum and intensity in the solar spectrum. Vanadium and titanium are also elements the lines of which are strong in the flash but comparatively weak in the solar spectrum, and the lines of these elements are also, as has been stated before (*Monthly Notices, R.A.S.* vol. li. No. 2, December 1890, p. 77, and vol. lviii. No. 7, May 1898), very much widened in all spots whether of the maximum or minimum epoch. It would seem to follow that the level of Sun-spots is the level of the upper more extensively diffused portion of the stratum of gas which gives the flash spectrum in eclipses. The following is a summary of the chief results which follow from the detailed study of this Sun-spot group :—

1. That the disturbed area of the solar corona of 1901 May 18 marked the time of the actual outburst of the spots.

2. The outburst occurred in a region which had been disturbed for at least a whole rotation of the Sun before the birth of the spots.

3. That in this case of the only great Sun-spot of an otherwise absolutely quiet year there is no connection between the solar storm and magnetic disturbances.

4. That the most widened lines in the spectra of Sun-spots in the red end of the spectrum are always faint lines, chiefly due to vanadium and titanium.

5. That the level of Sun-spots is the level of the upper more diffused gases which give the flash spectrum in total eclipses.

Stonyhurst College Observatory:
1902 *May* 4.

The Spectrum of Nova Persei 1901 *on and after September* 5.

By the Rev. Walter Sidgreaves, S.J.

A reproduction of the spectrum of the Nova, as photographed at Stonyhurst on August 27 and September 5, is given at p. 150 of the December number of the *Monthly Notices.* Since then forty-one photographs have been taken on twenty-eight nights, distributed as in the following list; in which the letters written after the dates have the same significations as in the wave-length tables of the paper referred to : viz. H the Hilger compound prism on the Perry-memorial Equatorial, and T the Thorp objective prism on the 4-inch finder :

September 6, H ; 11, T ; 14, H, T ; 15, H, T ; 24, H.
October 4, H, T ; 6, H, T ; 18, H ; 19, H, T ; 31, T.
November 1, H ; 2, T ; 14, T ; 22, H, T ; 23, H, T ; 28, H, T.
December 5, T ; 14, H, T ; 18, T ; 20, H, T.